

CLAIMS

1. A light-emitting element comprising:

a first layer;
a second layer; and
a third layer,

5 wherein the first, second and third layers are interposed between first and second electrodes which faces to each other;

wherein the first layer includes TPAQn and a first substance showing an electron accepting property to the TPAQn;

10 wherein the second layer includes a second substance of which an electron transporting property is higher than a hole transporting property, and a third substance showing an electron donating property to the second substance;

wherein the third layer contains a light-emitting substance;

wherein the first, second and third layers are sequentially stacked;

15 wherein the first layer is in contact with the first electrode;

wherein the third layer is in contact with the second electrode; and

wherein light is emitted when a voltage is applied such that a potential of the second electrode is higher than that of the first electrode.

20 2. A light-emitting element comprising:

a first layer;
a second layer; and
a third layer,

25 wherein the first, second and third layers are interposed between first and second electrodes which faces to each other;

wherein the first layer includes a TPAQn and a first substance showing an electron accepting property to the TPAQn;

wherein the second layer includes a second substance of which an electron transporting property is higher than a hole transporting property, and a third substance showing an electron donating property to the second substance;

wherein the third layer contains a light-emitting substance;

wherein the first layer is provided to be closer to the first electrode than the second layer;

5 wherein the third layer is provided to be closer to the second electrode than the second layer; and

wherein light is emitted when a voltage is applied such that a potential of the second electrode is higher than that of the first electrode.

3. The light-emitting element according to claim 1,

10 wherein the first layer includes the first substance such that a molar ratio of the first substance to the TPAQn is 0.5 or more and 2 or less.

4. The light-emitting element according to claim 3,

15 wherein the third substance is one substance selected from the group consisting of alkali metal oxides and alkali earth metal oxides.

5. A light-emitting element comprising:

a first layer;

a second layer; and

20 a third layer,

wherein the first, second and third layers are interposed between first and second electrodes which faces to each other;

wherein the first electrode is formed using a conductive material having a reflectance of 50 % or more and 100 % or less;

25 wherein the second electrode is formed using a conductive material which transmits visible light;

wherein the first layer contains a TPAQn and a first substance showing an electron accepting property to the TPAQn;

30 wherein the second layer contains a second substance of which an electron transporting property is higher than a hole transporting property, and a third substance

showing an electron donating property to the second substance;

wherein the third layer includes x layers (x is a given positive integer) containing a light-emitting layer;

wherein the first, second and third layers are sequentially stacked;

5 wherein the first layer is in contact with the first electrode;

wherein one layer of the third layer is in contact with the second layer;

wherein an x-th layer in the third layer is in contact with the second electrode;

wherein y-th layer ($y \leq x$, y is a positive integer) is interposed between the light-emitting layer and the second layer;

10 wherein light is emitted when a voltage is applied such that a potential of the second electrode is higher than that of the first electrode; and

wherein thicknesses of the first electrode and the second electrode are adjusted to satisfy expressions 1, 2 and 3:

$$n_i d_i + n_{ii} d_{ii} + \sum_{k=1}^y n_k d_k + n_j d_j = \frac{(2m-1)\lambda}{4} \quad \dots\dots 1$$

15 $0 \leq d_j \leq d_{emi} \quad \dots\dots 2$

$d_i \geq d_{ii} \quad \dots\dots 3$

wherein, in the expressions 1, 2 and 3, n_i indicates a refractive index of the first layer; d_i , a thickness of the first layer; n_{ii} , a refractive index of the second layer; d_{ii} , a thickness of the second layer; n_k , a refractive index of a k-th layer (k is a natural number) of layers interposed between the light-emitting layer and the second layer; d_k , a thickness of the k-th layer of the layers interposed between the light-emitting layer and the second layer; n_j , a refractive index of the light-emitting layer; d_j , a distance between a surface of the light-emitting layer in the first electrode side and a light-emitting region; λ , a wavelength of light emitted from the light-emitting element; m , a given positive integer; and d_{emi} , a thickness of the light-emitting layer.

6. A light-emitting device including, in a pixel portion, the light-emitting

element according to claim 1.

7. An electronic device using the light-emitting device according to claim 6 for a display portion.

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8. The light-emitting element according to claim 2, wherein the first layer includes the first substance such that a molar ratio of the first substance to the TPAQn is 0.5 or more and 2 or less.

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9. The light-emitting element according to claim 8, wherein the third substance is one substance selected from the group consisting of alkali metal oxides and alkali earth metal oxides.

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10. A light-emitting device including, in a pixel portion, the light-emitting element according to claim 2.

11. An electronic device using the light-emitting device according to claim 10 for a display portion.

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12. A light-emitting device including, in a pixel portion, the light-emitting element according to claim 5.

13. An electronic device using the light-emitting device according to claim 12 for a display portion.

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14. A light-emitting element comprising:

a first layer;
a second layer; and
a third layer,

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wherein the first, second and third layers are interposed between first and

second electrodes which faces to each other;

wherein the first layer includes an aromatic amine compound and a first substance showing an electron accepting property to the aromatic amine compound;

5 wherein the second layer includes a second substance of which an electron transporting property is higher than a hole transporting property, and a third substance showing an electron donating property to the second substance;

wherein the third layer contains a light-emitting substance;

wherein the first, second and third layers are sequentially stacked;

wherein the first layer is in contact with the first electrode;

10 wherein the third layer is in contact with the second electrode; and

wherein light is emitted when a voltage is applied such that a potential of the second electrode is higher than that of the first electrode.

15. A light-emitting element comprising:

a first layer;

a second layer; and

a third layer,

wherein the first, second and third layers are interposed between first and second electrodes which faces to each other;

20 wherein the first layer includes an aromatic amine compound and a first substance showing an electron accepting property to the aromatic amine compound;

wherein the second layer includes a second substance of which an electron transporting property is higher than a hole transporting property, and a third substance showing an electron donating property to the second substance;

25 wherein the third layer contains a light-emitting substance;

wherein the first layer is provided to be closer to the first electrode than the second layer;

wherein the third layer is provided to be closer to the second electrode than the second layer; and

30 wherein light is emitted when a voltage is applied such that a potential of the

second electrode is higher than that of the first electrode.

16. The light-emitting element according to claim 14,

wherein the first layer includes the first substance such that a molar ratio of the

5 first substance to the aromatic amine compound is 0.5 or more and 2 or less.

17. The light-emitting element according to claim 16,

wherein the third substance is one substance selected from the group consisting

of alkali metal oxides and alkali earth metal oxides.

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18. A light-emitting element comprising:

a first layer;

a second layer; and

a third layer,

15 wherein the first, second and third layers are interposed between first and second electrodes which faces to each other;

wherein the first electrode is formed using a conductive material having a reflectance of 50 % or more and 100 % or less;

20 wherein the second electrode is formed using a conductive material which transmits visible light;

wherein the first layer contains an aromatic amine compound and a first substance showing an electron accepting property to the aromatic amine compound;

25 wherein the second layer contains a second substance of which an electron transporting property is higher than a hole transporting property, and a third substance showing an electron donating property to the second substance;

wherein the third layer includes x layers (x is a given positive integer) containing a light-emitting layer;

wherein the first, second and third layers are sequentially stacked;

wherein the first layer is in contact with the first electrode;

30 wherein one layer of the third layer is in contact with the second layer;

wherein an x-th layer in the third layer is in contact with the second electrode;

wherein y-th layer ($y \leq x$, y is a positive integer) is interposed between the light-emitting layer and the second layer;

5 wherein light is emitted when a voltage is applied such that a potential of the second electrode is higher than that of the first electrode; and

wherein thicknesses of the first electrode and the second electrode are adjusted to satisfy expressions 1, 2 and 3:

$$n_i d_i + n_{ii} d_{ii} + \sum_{k=1}^y n_k d_k + n_j d_j = \frac{(2m-1)\lambda}{4} \quad \dots\dots 1$$

$$0 \leq d_j \leq d_{emi} \quad \dots\dots 2$$

$$10 \quad d_i \geq d_{ii} \quad \dots\dots 3$$

wherein, in the expressions 1, 2 and 3, n_i indicates a refractive index of the first layer; d_i , a thickness of the first layer; n_{ii} , a refractive index of the second layer; d_{ii} , a thickness of the second layer; n_k , a refractive index of a k-th layer (k is a natural number) of layers interposed between the light-emitting layer and the second layer; d_k , a thickness of the k-th layer of the layers interposed between the light-emitting layer and the second layer; n_j , a refractive index of the light-emitting layer; d_j , a distance between a surface of the light-emitting layer in the first electrode side and a light-emitting region; λ , a wavelength of light emitted from the light-emitting element; m , a given positive integer; and d_{emi} , a thickness of the light-emitting layer.

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19. A light-emitting device including, in a pixel portion, the light-emitting element according to claim 14.

25 20. An electronic device using the light-emitting device according to claim 19 for a display portion.

21. The light-emitting element according to claim 15,

wherein the first layer includes the first substance such that a molar ratio of the first substance to the aromatic amine compound is 0.5 or more and 2 or less.

22. The light-emitting element according to claim 21,

5 wherein the third substance is one substance selected from the group consisting of alkali metal oxides and alkali earth metal oxides.

23. A light-emitting device including, in a pixel portion, the light-emitting element according to claim 15.

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24. An electronic device using the light-emitting device according to claim 23 for a display portion.

15 25. A light-emitting device including, in a pixel portion, the light-emitting element according to claim 18.

26. An electronic device using the light-emitting device according to claim 25 for a display portion.